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Exploring the Socio-Demographic Profile of Rural Vegetable Growers Affected by the COVID-19 Pandemic: A Comparative Insight from Coastal Odisha

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Abstract

The COVID-19 pandemic not only caused severe health risks but also disrupted the global economy, significantly affecting various sectors, including agriculture. The present study explores the socio-demographic profile of rural vegetable growers impacted by the COVID-19 pandemic using key socio-demographic variables. An ex-post facto research design was adopted for the study. A multistage sampling technique was used for the selection of 240 vegetable growers across 8 villages in 4 blocks from 2 districts of Odisha for the study. The findings reveal that majority of the vegetable growers were middle aged (57.08%) had primary school level of education (37.50%), living in nuclear families (53.75%), with small family sizes (55.00%), are marginal farmers (56.67%), with a farming experience of 9 to 16 years (60.42%) and an annual income of ₹ 50,001 to 1,00,000 (35.00%), respectively. The study emphasizes the vulnerabilities faced by rural vegetable growers and underscores the need for strengthening their resilience to withstand future crises.

Keywords

COVID-19; Pandemic; Socio-demographic profile; Vegetable growers

Introduction

The COVID-19 pandemic has caused unprecedented disruptions across various sectors of the global economy. It has brought forth multifaceted challenges, exacerbating the existing vulnerabilities in many sectors, with agriculture and allied industries being among the most heavily affected. The effects of the pandemic on agriculture are complex, heterogeneous and dynamic, which vary for different groups of the rural population (Amjath-Babu *et al*.,

2020; Ceballos, Kannan and Kramer, 2020; Loayza and Pennings, 2020). Efforts to contain the spread of the virus in many countries interrupted the supply of agri-food products to markets and consumers both domestically and internationally (OECD, 2020). India's agrarian sector, being one of the largest agricultural producers in the world, plays a crucial role as the backbone of its economy, with a percentage share of 33% of the country's horticultural output. The significant percentage share of 59.9% remains the highest for vegetables among the total horticultural crops. India is one of the leading producers of vegetables in the world and ranks second after China (MoAFW, 2020). Vegetable cultivation plays a crucial role in Indian agriculture, serving as a primary source of income and sustenance for a significant portion of the rural population. Fear of losing such income can reduce compliance with measures to mitigate the spread of COVID-19, especially in rural areas (Coetzee and Kagee, 2020; Wright *et al*., 2020). The onset of the pandemic significantly disrupted vegetable cultivation due to its perishable nature, dependence on local markets and labour-intensive farming practices. Vegetable growers in rural areas are small-scale farmers who often rely on local and regional markets for selling their produce. The COVID-19 pandemic triggered nationwide lockdowns, introducing new challenges that threatened the livelihoods and food security of the rural vegetable growers. It can be further prolonged in the form of economic disruptions, lowered investments in the agriculture sector, government expenditure and financial assistance toward the farmers (Udmale *et al*., 2020). The economic dislocation resulting from infection control measures holds significant risk of hunger or worse (Barnett-Howell,Watson and Mobarak, 2021; Zetzsche and Consiglio, 2020). The prolonged period of lockdown greatly disrupted both the supply and demand for agri-food products (Mahendra Dev, 2020). The rural vegetable growers were extremely affected due to the restrictions on movement, closure of borders, transportation restrictions, labour shortages, market closures, supply chain disruptions and more generally adversely impacting food security and farming systems resilience (Stephens *et al*., 2020). As a result of COVID-19, national governments implemented various movement restrictions to curb the impact of the pandemic, disrupting both domestic and global agricultural value chains (Barrett, 2020; Elleby *et al*., 2020). The disruptions in agricultural supply chains have made farmers concerned about the negative impacts on their livelihood (Middendorf *et al*., 2021).

The pandemic emerged at an unfortunate time as farmers were preparing for the Rabi crop harvest, and the lockdown lasted until the production period of the Kharif crops, significantly affecting the farming activities of rural vegetable growers. There is no doubt that the lockdown had disproportionately affected the poor and daily wage earners including rural farmers (Cash and Patel, 2020). Issues reported with the finding of labour for harvest, transport to market, reduced demand by buyers, retailers and increased retail prices for vegetables (Pothan, Taguchi and Santini, 2020). As a result, Farmers struggled with major challenges in harvesting their produce, selling it and obtaining necessary agricultural inputs for the upcoming planting season (NABARD, 2020). The World Vegetable Center study found that 61% of vegetable farmers reported a lack of transport, 39% a lack of inputs and 32% a lack of labour, whereas, over 80% of farmers reported decline in sales and 90% reported a drop in farm income (Harris *et al*., 2020). The restrictions on the consumer movement and market access, along with the closure of food service establishments such as hotels, cafeterias and restaurants, caused a severe decrease in the demand for fresh vegetables (FAO, 2020). There is increase in the

damage of perishable agricultural commodities such as meat and vegetables (Nicola *et al*., 2020). Sudden closure of outlets left vegetable producers with a reduced customer base (GAIN, 2020). Due to a lack of proper storage facilities, large volumes of vegetables were thrown away (Termeer, Brouwer and de Boef, 2020). The vegetable farmers had shown the worst impacts in terms of wastage and reductions in nutrient-dense food consumption (Jaacks *et al*., 2021). It was found that household food expenditures declined during the lockdown, particularly for non-staples such as meat, eggs, fruit and vegetables (Gupta *et al*., 2022). The onset of the pandemic had severe socio-economic consequences with long-term effects on the income of poor people, including smallholder vegetable farmers (Sarker *et al*., 2020). The socio-demographic profile of rural vegetable growers helps to highlight the visible impacts of the pandemic on local agricultural practices, putting their livelihoods at significant risk. It refers to the demographic characteristics that define the population involved in vegetable farming in rural areas. These characteristics can vary based on the various socio-demographic factors such as age, education, family structure, landholding size and annual income. Exploring the socio-demographic profile of rural vegetable growers affected by the COVID-19 Pandemic is crucial to shape how these growers experience and respond to challenges such as market disruptions and health crises. The insights drawn from the study will help policymakers and development organizations to tailor interventions and support mechanisms. Stakeholders can develop more targeted policies in order to improve the livelihoods of rural vegetable growers, promoting their sustainability and resilience in order to mitigate the adverse effects of the pandemic or similar disruptions on agricultural practices in future.

Materials and Methods

Study Area

The current research was conducted in the state of Odisha, India, which is situated on the eastern coast with vivid agro-climatic conditions. Odisha ranks as the ninth largest state in India by area, constituting about 4.87 per cent of the country. It is an agrarian state which contributes 26 per cent to the State Gross Domestic Product (SGDP), where about 65 per cent of the workforce relies on agriculture and allied sectors for their daily livelihood. Odisha ranks seventh in vegetable production, contributing 4.7 per cent of the total production in the country. Vegetables are widely grown across the state with a total gross cropped area of 644.25 thousand hectares and a production potential of 8892.25 metric tons (Odisha Agriculture Statistics 2018-2019). The major vegetables produced in the state are sweet potato, brinjal, cabbage, cauliflower and okra.

Selection of Sample Area

A multistage sampling technique was used to draw a sample and capture a wide range of experiences of the vegetable growers in the research area. For this study, the purposive sampling method was utilized for the selection of the State, Agro-climatic Zones and District. Odisha comprises 10 agro-climatic zones out of which two zones, that is, North Eastern Coastal Plain and East and South Eastern Coastal Plain, were chosen for the study where vegetable farming is a primary agricultural activity. In addition to the agro-climatic zones, Balasore district (North Eastern Coastal Plain) and Cuttack district (East

and South Eastern Coastal Plain) were selected purposively based on the highest Gross cropped Area (GCA) (Odisha Agriculture Statistics 2018-2019) which refers to the maximum total area of the districts under vegetable cultivation along with the farmers reliance for livelihood. While, random sampling technique was followed for the selection of two blocks from each district and two-gram panchayat from each block, followed by a selection of a village from each gram panchayat. An ex-post facto research design was used to examine the variables with a total of 240 vegetable growers selected through proportionate random sampling, as illustrated in table 1. The study covered 2 districts of 4 blocks and 8 villages of Odisha.

Figure 1: Odisha state map

Data Collection and Analysis

Data collection was done from both primary and secondary sources. Primary data was gathered by face-to-face interviews with farmers where questions based on the various socio-demographic attributes, such as age of vegetable growers, level of education, family type, size of family, landholding size and annual income, were asked by using a structured interview schedule. Field visits and focused group discussions were done for a better understanding of the challenges faced by the vegetable growers in farming practices. The data collected from vegetable growers was analysed using descriptive statistics, allowing for a comprehensive analysis of the socio-demographic profile of rural vegetable growers affected by the COVID-19 pandemic.

Table 1: Selection of the sample area and respondents

State	Agro-climatic Zones	District	Block	Gram panchayat	Village	Total number of vegetable growers	No of selected respondents
Odisha	East & South Eastern coastal plain	Cuttack	Cuttack sadar	Khandeita	Sankhatras	60	17
				Aman	Sabalpur	136	39
			Niali	Jallarpur	Lunigan	153	44
				Nivarana	Rokida	70	20
	North eastern coastal plain	Balasore	Baliapal	Baniadiha	Bhanreswar	92	27
				Bodas	Tahalia	113	33
			Basta	Kulida	Demuria	82	24
				Santoshpur	Teghari	124	36
Total						830	240

$$\text{Proportional random sampling} = \frac{\text{Total number of vegetable growers}}{\text{Grand total no. of vegetable growers}} \times \text{Total no of samples of the study}$$

Results

The socio-demographic profile encompasses a wide range of characteristics which provide insight into the personal, economic and social aspects of the vegetable growers. This profile is crucial for assessing the needs, challenges and opportunities faced by the vegetable growers in rural regions. By analyzing the socio-demographic profile, we can identify how various elements affect farming practices, productivity, and overall livelihoods. Below are the detailed descriptions of the key elements that make up the socio-demographic profile of rural vegetable growers.

Age

Age is a key factor that impacts an individual's behaviour and maturity. It significantly affects their approach towards farming and adaptability to challenges, along with their overall resilience. It was observed from table 2 that a great majority (57.08%) of vegetable growers were middle-aged, followed by old age (24.59%) and young age (18.33%), respectively. A comparison between Balasore and Cuttack districts reveals that in Balasore District, the majority of vegetable growers (54.16%) fall within the middle age group (30-50 years), followed by 25.84% in the older age group (above 50 years) and 20.00% in the younger age group (up to 30 years). This distribution highlights the predominance of middle-aged growers in Balasore, reflecting a workforce that may possess significant farming experience while also being in a position to continue farming for a number of years. While in Cuttack District, a majority (60.00%) of the vegetable growers were in the middle age group of (30-50 years), followed by (23.34%) in the old age group (above 50 years) and (16.66%) in the younger age group (Up to 30 years), respectively.

Table 2: Distribution of vegetable growers according to their age

Sl. No.	*Age*	*Balasore District (n=120)*		*Cuttack District (n=120)*		*Total (n=240)*	
		f	*%*	*f*	*%*	*f*	*%*
1	Young age (Up to 30 years)	24	20.00	20	16.66	44	18.33
2	Middle age (30-50 years)	65	54.16	72	60.00	137	57.08
3	Old age (Above 50 years)	31	25.84	28	23.34	59	24.59
Total		120	100.00	120	100.00	240	100.00

Education

Education is the process which brings desirable change in the behaviour of human by influencing their knowledge. It impacts their ability to access resources. An educated individual is widely exposed to new ideas and information, which helps to improve their knowledge and skills. Table 3 revealed that a total of (37.50%) of vegetable growers were educated up to primary school level, followed by middle school (21.66%), could read only (11.67%), high school (11.25%), can read and write (8.33%), Illiterate (4.58%), graduates (3.34%), and post-graduates (1.67%), respectively. Concerning the educational level of Balasore district about (35.83%) of respondents were primary school leavers, (19.17%) were middle school graduates, (14.17%) could read only, (10.83%) could both read and write, (9.17%) attended high school, (2.50%) were graduates and (0.83%) were post graduates, respectively. In the Cuttack district, a majority (39.17%) of vegetable growers attended primary school, followed by (24.16%) and (13.33%) who were middle and high school graduates. Only 9.17% could read only, while 5.83% could both read and write. Approximately 4.17% were graduates, with 2.50% being post-graduates, respectively.

Table 3: Distribution of vegetable growers according to their education level

Sl.No.	*Education level*	*Balasore District (n=120)*		*Cuttack District (n=120)*		*Total (n=240)*	
		f	*%*	*f*	*%*	*f*	*%*
1	Illiterate	9	7.50	2	1.67	11	4.58
2	Can read-only	17	14.17	11	9.17	28	11.67
3	Can read and write	13	10.83	7	5.83	20	8.33
4	Primary school	43	35.83	47	39.17	90	37.50
5	Middle school	23	19.17	29	24.16	52	21.66
6	High school	11	9.17	16	13.33	27	11.25
7	Graduate	3	2.50	5	4.17	8	3.34
8	Above graduate	1	0.83	3	2.50	4	1.67
Total		120	100.00	120	100.00	240	100.00

Family Type

The family type of vegetable growers significantly influences farming operations, as family members often serve as the primary source of labour. In nuclear families, the availability of labour may be limited, leading to a greater reliance on hired workers, whereas in joint families, multiple members can contribute to various farming tasks, reducing labour costs and enhancing efficiency. The data presented in table 4 reveals

that the majority (53.75%) of vegetable growers belonged to nuclear families, whereas 46.25% were from joint families. In Balasore district, 34.17% of respondents come from nuclear families and 65.83% are from joint families, while in the Cuttack District, a majority of (73.33%) of vegetable growers are from nuclear families, while (26.67%) are from joint families. A comparison between Balasore and Cuttack districts indicates that in Balasore, the majority of vegetable growers belong to joint families, whereas in Cuttack, a higher number of vegetable growers come from nuclear families. This variation may be attributed to differences in socio-economic structures, landholding patterns, and urban influence.

Table 4: Distribution of vegetable growers according to their family type

Sl. No.	*Family type*	*Balasore District (n=120)*		*Cuttack District (n=120)*		*Total (n=240)*	
		f	*%*	*f*	*%*	*f*	*%*
1	Nuclear family	41	34.17	88	73.33	129	53.75
2	Joint family	79	65.83	32	26.67	111	46.25
Total		120	100.00	120	100.00	240	100.00

Family Size

Family size plays a crucial role in decision-making abilities, as it directly impacts the dynamics within a farming household. Each member contributes to agricultural activities, financial management, and overall household responsibilities, making the family function as a single unit. The Agriculture Census (2015–16) showed that 86% of farmers in India are either small or marginal (Department of Agriculture, 2020). Table 5 revealed that the maximum (55.00%) of the vegetable growers had small family sizes (up to 5 members), followed by (34.58%) and (10.42%) of medium (6 to 9 members) and big (10 or more members) family sizes, respectively. A comparison between Balasore and Cuttack district shows that a majority of (44.17%) have a small family size (up to 5 members), followed by (40.00%) and (15.83%) for medium (6 to 9 members) and large (10 and above members) families, respectively, in Balasore District. In contrast, in Cuttack District, the majority (65.83%) of vegetable growers have a small family size (up to 5 members), followed by 29.17% with a medium-sized family (6 to 9 members) and only 5.00% with a large family size (10 or more members).

Table 5: Distribution of vegetable growers according to their family size

Sl.No.	*Family size*	*Balasore District (n=120)*		*Cuttack District (n=120)*		*Total (n=240)*	
		f	*%*	*f*	*%*	*F*	*%*
1	Small (up to 5 Members)	53	44.17	79	65.83	132	55.00
2	Medium (6 to 9 Members)	48	40.00	35	29.17	83	34.58
3	Large (10 and above members)	19	15.83	06	5.00	25	10.42
	Total	120	100.00	120	100.00	240	100.00

Landholding

Land holding is the major asset of vegetable growers, which determines their economic potential and scale of farming activities. From the table 6 it is clear that maximum (56.67%) of vegetable growers are marginal farmers having (<2.5 acres) of land holdings, followed by (38.75%) of vegetable growers are small farmers with (2.51-5.0 acres) of land holdings and only (4.58%) of vegetable growers are big farmers with (>5.0 acres) of land holdings, respectively. The comparative analysis of landholding patterns between Balasore and Cuttack districts reveals that in Balasore, a majority (60.00%) of farmers are marginal farmers with landholdings of less than 2.5 acres, followed by 36.67% who are small farmers (2.51–5.0 acres) and only 3.33% own large farms (>5.0 acres). Similarly, in Cuttack district, marginal farmers also constitute the majority (53.33%), followed by 40.84% small farmers and 5.83% big farmers.

Table 6: Distribution of vegetable growers according to land holding

Sl.No.	*Category*	*Balasore District (n=120)*		*Cuttack District (n=120)*		*Total (n=240)*	
		f	*%*	*f*	*%*	*f*	*%*
1	Marginal Farmers (<2.5 acres)	72	60.00	64	53.33	136	56.67
2	Small Farmers (2.51-5.0 acres)	44	36.67	49	40.84	93	38.75
3	Big Farmers (> 5.0 acres)	04	03.33	07	05.83	11	04.58
Total		120	100.00	120	100.00	240	100.00

Farming Experience

Farming experience influences the decision-making ability of the vegetable growers and builds knowledge with the level of familiarity in farming to take risks. According to table 7, it is found that the majority (60.42%) of vegetable growers have a farming experience of 9 to 16 years followed by (26.67%) of vegetable growers with a farming experience of 17 years or more and (12.91%) with a farming experience of up to 8 years, respectively. A comparison between Balasore and Cuttack districts shows that a majority of (59.17%) of vegetable growers have farming experience ranging from 9 to 16 years, followed by (25.83%) with 17 years or more, and (15.00%) with up to 8 years, respectively, in Balasore District. Whereas a maximum of (61.67%) of vegetable growers have farming experience ranging from 9 to 16 years, followed by (27.50%) with 17 years or more and (10.83%) with up to 8 years, respectively, in Cuttack District.

Table 7: Distribution of vegetable growers according to farming experience

Sl. No.	*Farming experience*	*Balasore District (n=120)*		*Cuttack District (n=120)*		*Total (n=240)*	
		f	*%*	*f*	*%*	*f*	*%*
1	Up to 8 years	18	15.00	13	10.83	31	12.91
2	9 to 16 years	71	59.17	74	61.67	145	60.42
3	17 years and above	31	25.83	33	27.50	64	26.67
Total		120	100.00	120	100.00	240	100.00

Annual Income

Annual income plays a vital role in the socio-economic status of the vegetable growers. It motivates farmers for higher investment for farm development and projects the overall economic stability of the family. In a survey, it was found that the average income of the farming household stands at 8931 INR, out of which 35% comes from cultivation, 34% from wage earnings and 8% from livestock. A shortcoming in any of these income sources could adversely affect farming households (NABARD, 2018). Table 8 shows that majority (35.00%) of vegetable growers have an annual income of ₹ 50,001 to 1,00,000 followed by (27.92%) of vegetable growers have an annual income of ₹ 1,00,001 to 1,50,000, (21.25%) of vegetable growers had annual income Up to ₹ 50,000, (8.75%) of vegetable growers with annual income of ₹ 1,50,001 to 2,00,000 and (7.08%) of vegetable growers with annual income of Above ₹ 2,00,000, respectively. In Balasore district (37.50%) of vegetable growers have a yearly income ₹ 50,001 to 1,00,000 followed by (27.50%) have an annual income ₹ 1,00,001 to 1,50,000 (22.50%) had very annual income Up to ₹ 50,000, (6.67%) with annual income ₹ 1,50,001 to 2,00,000 and (5.83%) with annual income Above ₹ 2,00,000, respectively. Whereas, in Cuttack District, a majority of (32.50%) of persons have a yearly income of ₹ 50,001 to 1,00,000, followed by (28.33%) have an annual income of ₹ 1,00,001 to 1,50,000. (20.00%) had annual income Up to ₹ 50,000, followed by (10.84%) with annual income₹ 1,50,001 to 2,00,000 and (8.33%) with annual income Above ₹ 2,00,000, respectively.

Table 8: Distribution of vegetable growers according to their annual income

Sl.No.	*Income Category*	*Balasore District (n=120)*		*Cuttack District (n=120)*		*Total (n=240)*	
		f	*%*	*f*	*%*	*f*	*%*
1	Up to ₹ 50,000	27	22.50	24	20.00	51	21.25
2	₹ 50,001 to 1,00,000	45	37.50	39	32.50	84	35.00
3	₹ 1,00,001 to 1,50,000	33	27.50	34	28.33	67	27.92
4	₹ 1,50,001 to 2,00,000	08	6.67	13	10.84	21	8.75
5	Above ₹ 2,00,000	07	5.83	10	8.33	17	7.08
Total		120	100.00	120	100.00	240	100.00

Discussion

Age

The aggregate statistics from both districts, as illustrated in figure 2, indicate that the majority of vegetable growers belong to the middle-aged group. This trend may be attributed to the fact that middle-aged growers tend to be more stable and bear greater family responsibilities, often serving as the primary earners for their households. In contrast, older growers continue farming due to their extensive experience and limited alternative livelihood options. Meanwhile, the younger generation shows the least involvement in vegetable cultivation, likely due to a lack of interest and the tendency to migrate to nearby cities for education and diverse employment opportunities.

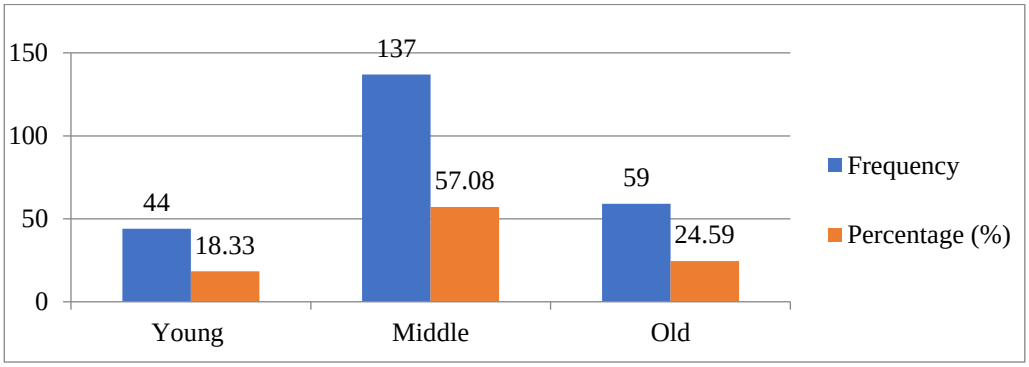

Figure 2: Distribution of vegetable growers according to their age

Education

The combined results from both districts in figure 3 concluded that most of the vegetable growers have a primary school and middle school educational level. The probable reasons might be the lack of awareness about the importance of education, poor financial conditions and the unavailability of educational facilities in their villages for studies. They often have to travel to different cities for education, incurring additional expenses such as tuition fees, accommodation, and other living costs. This increases the economic burden on their families, making it difficult for them to invest in agriculture or contribute to farming activities. As a result, younger individuals are less inclined to pursue vegetable cultivation as a primary livelihood.

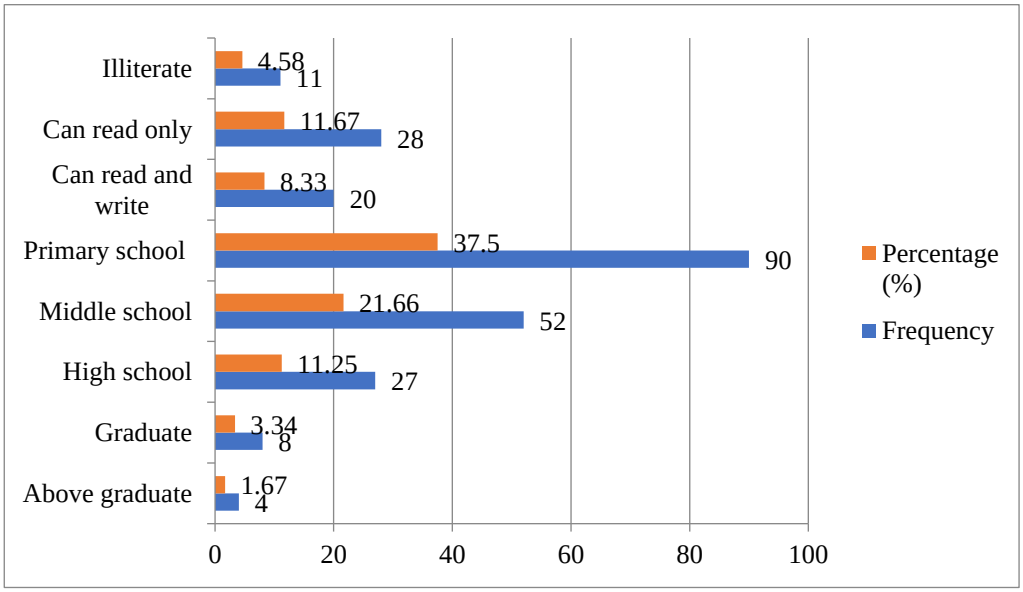

Figure 3: Distribution of vegetable growers according to their education level

Family Type

The combined findings from both districts, as illustrated in figure 4, indicate that the majority of vegetable growers belong to nuclear families rather than joint families. This

trend can be attributed to several factors, including the disintegration of traditional farm families under urban influence, evolving social norms, and a growing preference for individuality among the younger generation. The shift towards nuclear family structures may also be influenced by economic constraints, migration for better employment opportunities, and the desire for independent decision-making in agricultural and household matters.

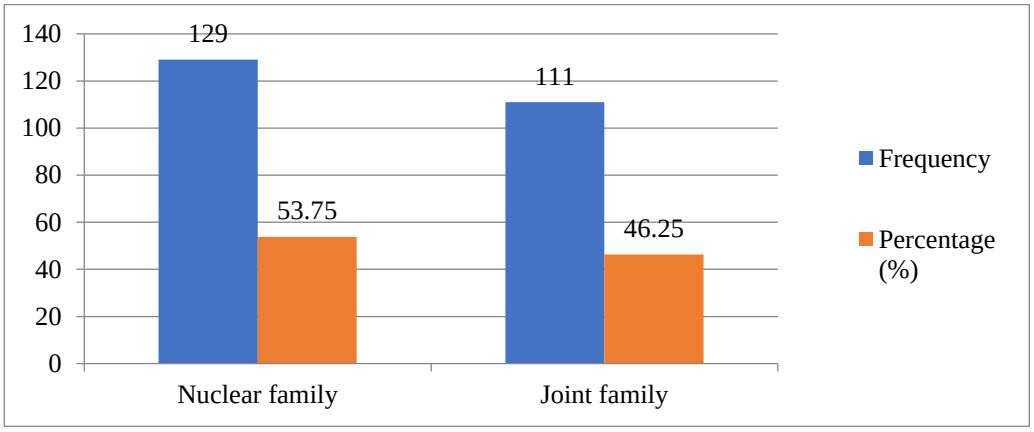

Figure 4: Distribution of vegetable growers according to their family type

Family Size

The aggregate statistics from both districts in figure 5 concluded that most of the vegetable growers had small family size (up to 5 members), followed by medium family size (6 to 9 members), and the least belonged to large family size (10 or more members). The reason might be due to various structural changes in the rural family systems. People in rural areas are more aware of family planning, not only that small families are less prone to poverty traps with comparatively low economic pressure, along with scope for good financial stability as household resources are shared among fewer members. Thus, people make independent lifestyle choices for their family and can lead a better life.

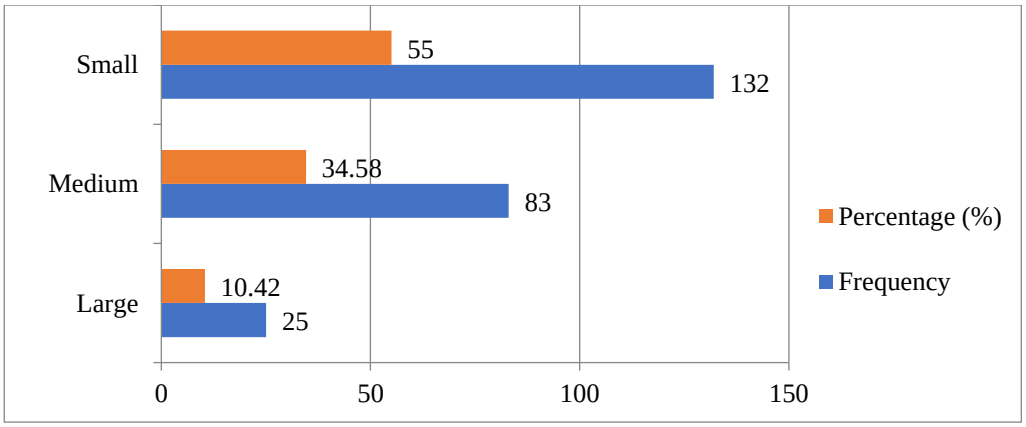

Figure 5: Distribution of vegetable growers according to their family size

Landholding

The combined findings from both districts in figure 6 indicate that the majority of the vegetable growers are marginal farmers having (<2.5 acres) of land holdings, followed by small farmers with (2.51-5.0 acres) of land holdings, and the least are big farmers with (> 5.0 acres) of land holdings. The probable reason for this trend might be the increasing number of family members, leading to the fragmentation of ancestral landholdings passed down through generations. As land gets subdivided among heirs, individual land parcels shrink, resulting in a higher proportion of marginal and small landholders. Additionally, the prevailing trend of converting agricultural land for non-agricultural purposes, such as real estate development, industrial expansion, and infrastructure projects, has further reduced the availability of land for vegetable cultivation. This shift not only limits the productivity and profitability of vegetable growers but also poses a long-term threat to sustainable agricultural practices in the region.

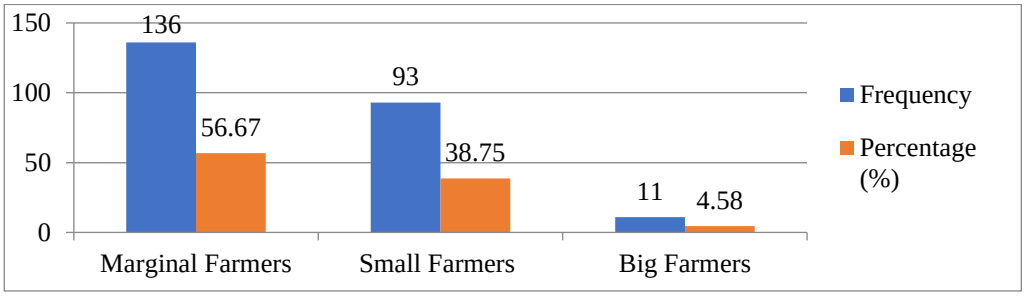

Figure 6: Distribution of vegetable growers according to land holding

Farming Experience

The combined statistics from both districts in figure 7 concluded that majority of the vegetable growers have a farming experience of 9 to 16 years followed by farming experience of 17 years or more and least have a farming experience of up to 8 years The probable reason may be that most of the vegetable growers belong to the farming families or depend on vegetable cultivation for their livelihood. Due to the lack of facilities for formal education and other employment opportunities, farming is considered a source of primary income for rural households.

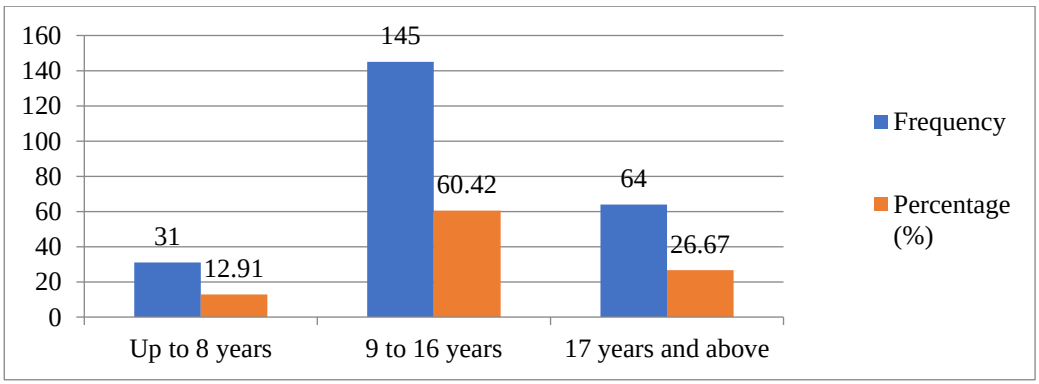

Figure 7: Distribution of vegetable growers according to farming experience

Annual Income

According to the combined findings of both districts in figure 8, it can be concluded that most of the vegetable growers have a low to medium level of annual income. The possible cause may be that vegetable cultivation is regarded as the primary source of income for their livelihood. Most of the vegetable growers have marginal to small land holdings, which have low productivity due to one or other factors, along with inadequate marketing facilities, affecting their annual income.

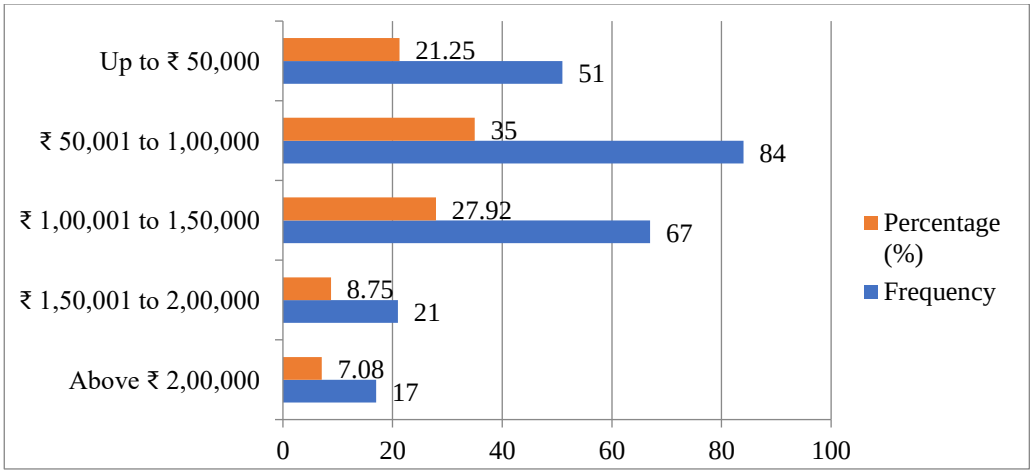

Figure 8: Distribution of vegetable growers according to their annual income

Conclusion

The COVID-19 pandemic had an adverse impact on rural vegetable growers, highlighting the socio-demographic characteristics of farmers. It provides valuable insights into the socio-demographic profile of rural vegetable growers and several key areas of vulnerabilities in which the pandemic has impacted their livelihoods. The results underscore the critical role of the socio-demographic factors, such as age, education, family structure, landholding size and annual income play in determining their resilience and the ability of these farmers to cope with the challenges during crises. The findings of the study revealed that majority of the vegetable growers were middle aged (57.08%) had primary school level of education (37.50%) living in nuclear families (53.75%) with small family size (55.00%) are marginal farmers (56.67%) with a farming experience of 9 to 16 years (60.42%) and an annual income of ₹ 50,001 to 1,00,000 (35.00%), respectively. It was observed that older farmers, having limited formal education with large families and small-scale growers, were the most vulnerable to the pandemic's disruptions. In contrast, farmers who were younger, more educated, with larger land holdings and small families showed greater adaptability to navigate the crisis. Odisha's exposure to previous events of natural disasters has led to the repurposing of crisis prevention measures which were already in place (Lancet, 2020). Despite the challenges, many rural vegetable growers adopted innovative coping strategies, including diversifying their crops, utilizing direct marketing channels and increasing reliance on digital platforms to access information and markets. The crucial information on the socio-demographic factors is essential for ensuring effective delivery of government

support during crises, especially those from vulnerable socio-demographic backgrounds. Major efforts should be made to sustain the food supply chains (Reardon *et al*., 2020). Sustainability of global food systems has been a growing area of research interest in recent years (Brown *et al*., 2021). Support in the form of financial aid can strengthen their ability to cope with future crises. The pandemic has exposed the fragility of rural vegetable growers. As a result, global policymakers anticipated that COVID-19 would have a substantial effect on productivity and food security, especially among the poor in rural areas (UNESCAP, 2020). Of immediate concern being the disruptions to the food system and its impact on food security (Torero, 2020). The challenge arises of rethinking planning around food and nutritional security to include the more comprehensive notion of sustained livelihood options (Moseley and Battersby, 2020). By addressing the socio-demographic factors, stakeholders can help to strengthen the resilience of rural vegetable growers essential for sustaining future challenges. Additionally, government policies should focus on robust agricultural policies, improving infrastructure, fostering digital literacy, facilitating training and modern interventions in adaptive farming practices for ensuring food security and long-term sustainability of rural agriculture.

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Authors' Contributions (in accordance with ICMJE criteria for authorship)

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Conceived and designed the research or analysis	Yes	No
Collected the data	Yes	No
Contributed to data analysis & interpretation	Yes	Yes
Wrote the article/paper	Yes	Yes
Critical revision of the article/paper	No	Yes
Editing of the article/paper	No	Yes
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